a cathode mix from a current collector, which both have been problems.

Japanese Patent Laying-Open No. Hei 8-45498 proposes a technique for limiting expansion and shrinkage of a cathode mix in its entirety by combining a lithium-manganese complex oxide with a lithium-nickel complex oxide, based on the finding that the lithium-manganese complex oxide undergoes crystal expansion while the lithium-nickel complex oxide undergoes crystal shrinkage when lithium ions are inserted thereinto.

Also, Japanese Patent Laying-Open Nos. Hei 11-3698 and Hei 1-54122 propose a technique for improving electronic conduction of a cathode mix as a whole and thus cycle performance characteristics by combining a lithium-nickel complex oxide, a lithium-cobalt complex oxide and a lithium-manganese complex oxide, based on the finding that the lithium-cobalt complex oxide exhibits a higher electronic conduction than the lithium-manganese complex oxide.

While such combinations achieve improvements to certain degrees, there still remains a room for improving cycle performance characteristics. The inventors of the present application have studied the reduction in capacity with cycling for a positive electrode material (active material) containing a mixture of a spinel lithium-manganese complex oxide and a lithium-nickel complex oxide and found that its

load characteristics decrease with increasing cycles. That is, the capacity reduction has been observed to occur when its capacities both initially and after cycles are measured at a relatively high current, e.g., at a 1 C discharge rate, as a result of the reduced load characteristics.

DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a nonaqueous electrolyte secondary battery which has a high capacity retention and exhibits improved cycle performance characteristics.

A nonaqueous electrolyte secondary battery in accordance with a first aspect of the present invention is characterized as using a mixture of a first oxide and a second oxide for the positive electrode material. The first oxide is a spinel oxide consisting substantially of lithium, manganese, a metal other than manganese, and oxygen. The second oxide is different in composition from the first oxide and consists substantially of lithium, nickel, cobalt, a metal other than nickel and cobalt, and oxygen.

The first aspect of the present invention is described below.

A specific example of the first oxide is an oxide derived via substitution of other element for a part of manganese in a lithium-manganese complex oxide. A specific

example of the second oxide is an oxide derived via substitution of cobalt and other element for a part of nickel in a lithium-nickel complex oxide.

The use, in combination, of the first oxide derived via substitution of other element for a part of manganese in the spinel lithium-manganese complex oxide and the second oxide derived via substitution of cobalt and other element for a part of nickel in the lithium-nickel complex oxide is effective to suppress deterioration of load characteristics with cycling. A first reason for this is considered due to the inclusion of dissimilar elements, in the form of a solid solution, that causes active material comprising the first and second oxides to undergo a change in electronic state to the extent that improves electronic conduction of the active material in its entirety. A second reason is considered due to the use, in combination, of the lithium-manganese complex oxide which undergoes crystal expansion when lithium ions are inserted thereinto and the lithium-nickel-cobalt complex oxide which undergoes crystal shrinkage when lithium ions are inserted thereinto, that is effective to maintain stable contact between particles of the first and second oxides during repetitive cycling.

Examples of first oxides include spinel lithium-manganese complex oxides represented by the compositional formula $Li_xMn_{2-y}M1_yO_{4+z}$ (where M1 is at least one element